## REMARKS

The present application is a continuation of Application No. 09/877,385, filed on June 22, 2001 (the "Parent Application"). Independent claims 1, 14, 16, and 21 correspond to parent claims 18, 46, 55 and 61, which were entered prior to the citation of Liu in the Parent Application.

*Claim Amendments*

Applicants have amended claims 4 and 8, to correct minor typographical and grammatical errors.

*Claims 1-15 and 21-24*

Certain claims in the Parent Application having certain limitations similar to those of claims 1-15 and 21-24 were rejected under 35 U.S.C. 102(e) as anticipated by Liu.

It is respectfully submitted that claims 1-15 and 21-24 include limitations that clearly distinguish these claims from the cited art. Accordingly, Applicant respectfully traverses the rejection.

The present invention provides an apparatus and method for performing analog-to-digital conversion of a signal characterized by wide dynamic range. The present invention can be applied to a variety of fields, e.g., to generate magnetic resonance images (MRI).

In accordance with an embodiment of the invention, an NMR sequence & timing controller initiates the injection of RF frequency pulses into an imaging volume [paragraph 29 of the Specification]. A receiver module receives a resonance signal [¶31]. The resonance signal is amplified by a plurality of amplifiers, converted to digital form by a respective ADC,

and digitally downconverted to baseband by a downconverter [¶31]. The downconverted signals are applied to a digital signal processor (DSP) which selects the signal with the highest SNR whose ADC is not over-saturated [¶31]. The signal on the selected channel is multiplied by a complex coefficient that corrects for gain and phase distortion to ensure uniform scale and phase alignment of signals used for imaging [¶37]. Several of these functions may be performed by a single DSP, as recited by claim 1 (a single DSP selects the signal "having a lowest distortion," and corrects "for lack of phase coherence and differing gain").

An embodiment of the present invention makes it possible to use data from multiple signals having different gain factors in generating a single image. Applicant wishes to emphasize the importance of applying phase correction in such a situation. As is well-known in the art, signals generated using different gains have different phases. If an image is generated using data from multiple signals with different phases, the resulting image will exhibit aliasing effects such as blurriness and other edge artifacts. Therefore, because the invention is utilized to generate an image from multiple signals with different gains, it is necessary to perform phase correction for each signal after the gain is applied and before the image is generated.

Liu discloses a conventional technique for generating MRI images, referred to as a "multi-echo" technique (Liu, column 3, lines 40-45). This technique comprises applying a pulse sequence to produce a resonance signal that includes a plurality of echos (col. 2, lines 58-62). Echos are grouped into sets, and each set of echos is sampled into its own k-space matrix. A single gain factor is selected for all the echos in a respective set (col. 7, lines 16-20). An image is created from a single set of echos (col. 7, lines 2-4) by applying an Inverse Fourier Transform to the k-space matrix associated with the set of echos (col. 1, lines 40-45).

It is important to reiterate here that in the Liu technique, all echos within a set have the same gain factor. All echos within a set therefore have the same phase.

Nowhere does Liu teach or suggest a digital signal processor "configured to correct for lack of phase coherence and differing gain in said digital signals respective to each of said channels, whereby said one of said digital signals remains normalized with respect to others of said digital signals when said others are selected," as required by claim 1. There is no explicit discussion of phase correction in Liu.

Nor is there any suggestion of phase correction in Liu, because phase correction is not needed. As discussed above, phase correction is necessary when data received from multiple signals generated using different gain factors is combined, in order to correct for phase differences resulting from the different gains. However, in the multi-echo technique disclosed in Liu, each k-space matrix, and each corresponding image, is constructed using data from one or more echos all of which have the same gain factor (col. 7, lines 2-20). In other words, in each respective k-space matrix generated using Liu's technique, there is no phase difference among echo signals in a set. Thus, there is no need to apply phase correction to the echo signals used to generate an image. As such, claims 1, and its dependent claims, are patentable over the cited art. Independent claims 4, 14, 16, and 21-24 all include a phase correction limitation similar to that of claim 1; therefore, the arguments set forth above apply equally to these claims, and to their dependent claims.

*Claim 25*

A claim in the Parent Application having claim limitations similar to those of claim 25 was rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Liu in view of

Rapp. Claim 25 recites "a lookup table indicating predetermined gain ratio values for various encoding levels." By utilizing such a lookup table, a gain setting module can, at the beginning of each new phase encoding level, set the switch to the corresponding gain to apply the gain that maps the resonance signal to the fullest possible range of the analog-to-digital converter (specification, page 18, lies 12-16). In the context of claim 25, a respective phase encoding level corresponds to an individual signal (page 4, lines 17-20); therefore, the lookup table recited in claim 25 contains data pertaining to multiple signals.

As indicated in the Office Action, neither Liu nor Rapp explicitly discloses the lookup table of claim 25. Liu and Rapp in combination also fail to suggest the lookup table recited in claim 25. Rapp discloses a sequence control device connected to a switch capable of selecting one output from among the outputs of multiple analog-to-digital converters. (Rapp, col. 4, lines 23-30). In accordance with Rapp, the controller causes the switch to switch to various selected outputs as a single signal changes in time, "based on knowledge of the future signal curve" (Rapp, col. 4, lines 24-27). Rapp's technique teaches using knowledge of a single signal's behavior <u>over time</u> to determine which ADC to select. However, nowhere does Rapp's memory-based technique suggest constructing a lookup table containing data pertaining to multiple signals corresponding to <u>different</u> phase-encoding levels. As such, claim 25 is patentable over the cited art.

## Conclusion

In view of the foregoing, each of claims 1-25 is believed to be in condition for allowance. Accordingly, allowance of the application is earnestly solicited.

Respectfully submitted,

By ______________________

Brandon N. Sklar
Attorney for Applicants
Reg. No. 31,667
212-836-8653

Date: February 5, 2004